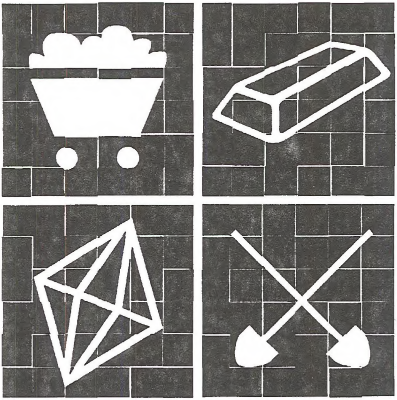

Training Guide for Solid Minerals Specialists GIS

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Bureau of Land Management
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User Documentation Version 8-20-92

Training Guide for Solid Minerals Specialists

In response to a growing demand within the Bureau of Land Management for GIS training beyond the introductory level, several advanced courses have been developed. This manual is to be used in training BLM minerals specialists to use MOSS/MAPS for solid minerals applications. While this text should be of continued value to GIS users, it is not meant to replace more complete documentation and user manuals already in existence. Rather, this is a training manual and a quick reference document.

Acknowledgments

GIS — Training Guide for Solid Minerals Specialists

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Some information in this text is based on existing documentation, especially the *MOSS User's Manual*, and *Introduction to Geographic Information Systems*. Both documents were originally written by the Western Energy and Land Use Team (WELUT), Division of Biological Services, Research and Development, Fish and Wildlife Service, U.S. Department of the Interior. Participants in this advanced GIS course will find uses for each of the above documents. More detailed information on MOSS and MAPS commands may be found in the *MOSS User's Manual*.

Detailed information on Primos use and Prime hardware and software may be found in Prime documents.

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Chapter One: Systems Operations— A Review

In this chapter you will review

- *GIS directory structures*
- *MOSS-family systems interfaces*
- *PRIMOS system commands*
- *Disk management*
- *Text editor (EMACS)*
- *Non-interactive processing*
- *GIS project Management*

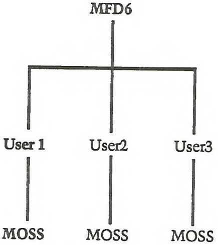
A review exercise will follow this chapter.

Directory Structure

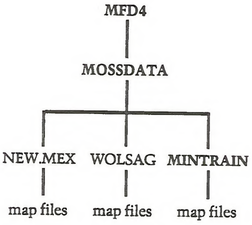
<MFD>	Master File Directory is the basic unit of storage on the PRIME.
<MFD>UFD>	User File Directory is a sub-directory of the Master File Directory; it may contain many files and other sub-directories.

Examples:

1. Pathname: <MFD6>user1>MOSS



2. Pathname: <MFD4>MOSSDATA>MINTRAIN



MOSS Family Systems Interfaces

Several software packages (systems) may be required to satisfy BLM GIS project requirements. For example, a solid mineral application of a GIS may require you to incorporate the Geological Survey's Digital Line Graph (DLG) data into MOSS. The system DLGS2O converts DLG standard format to optional format, and then the system DLG3 converts the DLG optional format to a data file that can be imported into MOSS. Therefore, an understanding of MOSS-family system interfaces is essential to GIS project planning and implementation.

Figure 1.1 is a diagram that shows the various systems available and how they interface within the MOSS-family software.

Table 1.1 lists the system names and their functions.

Figure 1.1 MOSS-Family Software System Interface

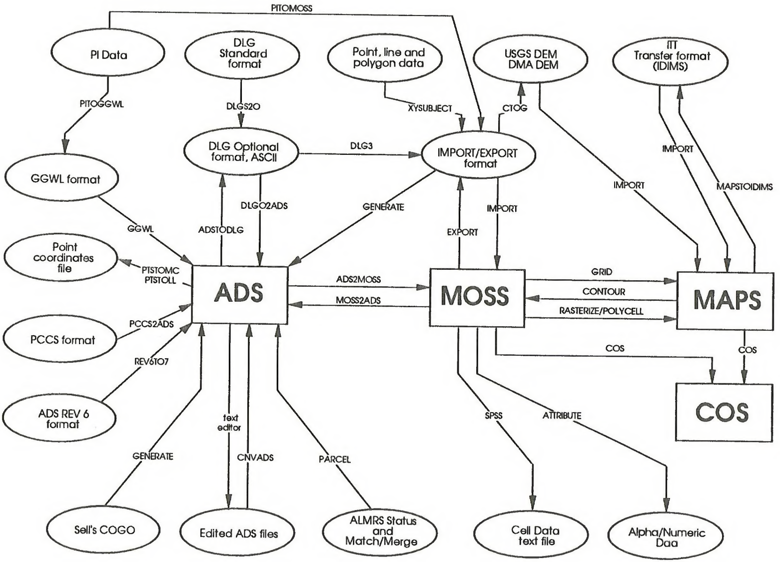


TABLE 1.1. SYSTEM INTERFACE REFERENCE

PROGRAM NAME	FUNCTION	LOCATION
ADS.ADSTODLG	Converts ADS files to DLG optional format	ADS menu
ADS2MOSS	Converts ADS files to MOSS	ADS menu
ADS GENERATE	Produces ADS files from COGO or ASCII files Also allows screen digitizing.	ADS EDIT option
CNVADS	Converts SAM file to DAM file	IS>ADS>CNVADS.RUN
CONTOUR	Converts cell data to line data	MOSS command
CTOG	Converts MOSS IMPORT/EXPORT format to DEM	MOSS UTILITY
DLGO2ADS	Converts DLG optional format to ADS	ADS menu
DLGS2O	Converts DLG standard format to optional	IS>MOSS>DLGS2O.RUN
DLG3	Converts DLG optional format to MOSS IMPORT/EXPORT format.	MOSS UTILITY
EXPORT	Converts MOSS files to IMPORT/EXPORT format	MOSS command
ADS.GGWL	Converts GGWL files to ADS	ADS menu
GRID	Converts point data to cell data	MOSS command
IMPORT (MAPS)	IDIMS byte or word, USGS DEM, DMA 3 arc-second DEM to MAPS.	MAPS command
IMPORT (MOSS)	IMPORT/EXPORT format to MOSS	MOSS command
MAPSTOIDIMS	MAPS files to IDIMS format	CMDNCO CPL
MOSS2ADS	MOSS files to ADS	MOSS command
MOSS2LGS	MOSS files (type 1,2,3) to LGS format	IS>MOSS>MOSS2LGS.RUN
ADS.PARCEL	ADS landlines and ALMRS status or match/merge files to ADS.	ADS menu
PCCS2ADS	Converts PCCS files to ADS	ADS menu
PITOGGWL	EMACS-edited Petroleum Information (PI) data to ADS.GGWL	ADS (stand alone)
PITOMOSS	Petroleum Information data to MOSS IMPORT/EXPORT format.	CMDNCO CPL
POLYCELL	MOSS (vector) files to MAPS (cell) files	MOSS command
RASTERIZE	MOSS (vector) files to MAPS (cell) files	MAPS command
ADS.REV6TO7	ADS Rev.6 files to ADS Rev.7	ADS menu
SPSS	MAPS raster data to ASCII file.	MOSS command
XYSUBJECT	Point, line and polygon data to MOSS IMPORT/EXPORT format.	MOSS UTILITY

PRIMOS Commands

The PRIMOS commands most frequently used during GIS sessions are listed below. For more detailed information, see the PRIMOS Commands Reference Guide or use the PRIMOS HELP command.

AB -AC	creates abbreviations in the text editor
ABBREV	defines user's abbreviations
ATTACH	changes user's current directory
CHANGE_PASSWORD	changes a user login password
CLOSE ALL	closes all files that may be opened
CNAME	changes a file name
COMOUTPUT	opens "como" file and stores log of session
CONTROL P	terminates current processing
COPY	copies file or directory
DELETE	deletes a file or directory
DOWN	changes to directory below current directory
EDIT_ACCESS	edits existing access control list*
EMACS	accesses the text editor
HELP	provides information about PRIMOS commands
ICE	initiates logout/login automatically
LD	lists contents of directory
LIST_ACCESS	lists access of a file or directory*
LOGIN	initiates PRIMOS session
LOGOUT	terminates PRIMOS session
SLIST	displays file contents on screen
SPOOL	sends files to line printer
STATUS	displays system information regarding disks, users, and devices.
SYSTEM	executes PRIMOS command with MOSS
UP	changes to directory above current directory
WHERE	gives pathname of current directory

* Access codes are: Protect; Delete; Add; List; Use; Read; Write; ALL; and NONE

Disk Management

Disk Space

The amount of disk space varies with the type of data used. For example, one public land survey map required 55,000 bytes (27 records) in vector form and 78,000 bytes (38 records) in raster (cell) form. (One record equals 2,048 bytes or 16,384 bits.)

Disk space also varies with thematic types. A few data themes and their estimated disk space requirements are as follows:

THEME	Megabytes per 7-1/2 minute quadrangle
LANDNET	0.07
GEOLOGIC	0.557
SOIL	0.548
SURFACE WATER	0.021
ELEVATION	4.35

When you are determining space requirements for MFDs and UFDs, the following PRIMOS commands can be useful:

AVAIL	Displays disk usage statistics (total number of records and number of available records in a directory)
SIZE	Displays the size of a file or the number of entries in a directory
LD	Displays the number of records and quota for a directory, along with the directory contents

* 1 record = 2048 bytes or 16,384 bits

File Cleanup and Deletions

In PRIMOS, use **DELETE** to delete a file or directory.

In MOSS/MAPS, use **DELETE** to delete maps from your working directory. Maps in the master directory can only be deleted if you have access to do so. The **DELETE** command will erase the map file from your directory and remove the name of the map from your polygon.dt file. If you want to remove the map name from the polygon.dt file but not erase the map file, use the command **UTILITY-DATABTEST** option.

Archiving

In order to free space on the system disk for other processing, contact your systems operator to archive inactive data and map files onto a magnetic tape.

The Text Editor (EMACS)

You can use the EMACS text-editing program to create and edit text files. For example, you can use it to create CPL (Command Processing Language) files to be used for batch jobs and data files to be used as multiple attribute files in MOSS.

Before using EMACS, you must use the reset command to set the terminal CODE to ANSI. To invoke EMACS, you must use the command

```
EMACS -TTP VT100 filename -NOXOFF
```

Using the PRIMOS command "AB-AC", you can create a two-letter abbreviation that invokes the EMACS editor. It is much easier to type a two-letter abbreviation than to type the long command every time you want to use EMACS. The following example creates an abbreviation "EM":

AB -AC EM EMACS -TTP VT100 %1% -NOXOFF

A brief listing of useful EMACS commands are listed in Table 1.2.

TABLE 1.2. Useful EMACS commands

Viewing Screens:	
CTRL V	Move forward one screen
ESC V	Move backward one screen
CTRL L	'Refresh' the current screen and center screen where cursor is
Cursor Movement:	
CTRL F	Move forward a character
CTRL B	Move backward a character
ESC F	Move forward one word
ESC B	Move backward one word
ESC E	Move forward one sentence
ESC A	Move backward one sentence
CTRL]	Move forward one paragraph
CTRL [	Move backward one paragraph
CTRL N	Move down one line
CTRL Z	Move up one line
CTRL A	Move to beginning of line
CTRL E	Move to end of line
ESC <	Go to beginning of file
ESC >	Go to end of file
Saving and Creating Files:	
CTRL X CTRL F	Find or create file you specify
CTRL X CTRL L	Insert a file
CTRL X CTRL S	Save changes in current file (some systems use CTRL X ESC S)
CTRL X CTRL W	Write to a file
CTRL X CTRL C	Exit EMACS and return to PRIMOS
Removing and Restoring Text:	
(bksp)	Delete the character immediately before cursor
CTRL D	Delete the character immediately after cursor
ESC D	Delete next word
ESC (bksp)	Delete previous word
CTRL X CTRL K	Delete text from start of line to cursor
CTRL K	Delete text from cursor to end of line and put in kill ring
CTRL Y	Yank back text in kill ring and insert it in file at cursor
ESC Y	Yank prior text from kill ring and replace most recently yanked item
CTRL W	Delete region bounded by the mark and cursor and copy to kill ring
Marking Text (The cursor and mark specify the ends of a region.)	
CTRL @	Set a mark at cursor
CTRL X H	Mark entire buffer
CTRL X CTRL X	Exchange the positions of the mark and cursor
Searching and Replacing:	
CTRL S	Search forward (some systems use ESC S)
CTRL R	Search reverse
ESC X Replace	Globally replace one string with another
ESC %	Query before replacing
Help Commands:	
CTRL _	Invoke online help
C	Explain the command typed in by user
A	List commands related to subject typed in by user
D	Invoke the "Describe" function
L	List last 20 characters typed
?	Summarize all of above options at top of screen

TABLE 1.2. Useful EMACS commands (continued)

Case Conversions	
ESC C	Capitalize word
ESC U	Make work all upper case word
ESC L	Make work all lower case word
Macros:	
CTRL X (	Begin macro definition
CTRL X)	End macro definition
CTRL X E	Execute most recently defined keyboard macro
ESC # CTRL C	Repeat the last command # times (use CTRL X E first for a macro)
Other Useful Commands:	
CTRL G	Cancel partially typed command
CTRL O	Insert new line text
ESC #	Repeat next command # times
CTRL C	Repeat previous action or command
CTRL T	Transpose characters
ESC T	Transpose words

Non-Interactive Processing

Non-interactive processing allows you to run a series of commands within a CPL file. The advantages of non-interactive processing are that you can:

* Continue other tasks without being tied to the display terminal

* Create long, complex strings of commands or processes that you can use again

* Use the CPL file to log processes for a project

* Easily alter command parameters or variables

Create a CPL File

Refer to the following example of a CPL file named TEST.CPL. Comment lines begin with `/*`. The number of CPL lines for a MOSS command must be the same as if you were using the command interactively.

```
/* This is a MOSS processing CPL named TEST.CPL

&DATA MOSS                /* invokes MOSS until &END

MINTRAIN                  /* MOSS project directory

TEAM1                     /* MOSS user name

SYSTEM COMO TEST.OUT      /* opens como file "TEST.OUT"

OPEN SJCOAL               /* opens desired MOSS project

FREE ALL                  /* frees existing active table

SELECT LANDLINES ALL      /* select map

WINDOW 1                  /* window to this map

SELECT COAL.PTS ALL       /* select second map

SELECT SJ.LEASE ALL       /* select third map

ACTIVE                    /* list active table

PLOT 2 3                  /* plot maps 2 and 3

BYE                       /* exit MOSS session

&END                      /* end of MOSS data

COMO -END                 /* close como file

&RETURN                   /* end of CPL file
```

SUBMIT A CPL FILE AS A BATCH JOB

To submit a CPL file as a batch job, simply enter the PRIMOS command:

```
JOB filename
```

After you have submitted the job to the batch queue, the batch Job Identification Number will be displayed.

CONTROLLING A BATCH JOB

These PRIMOS commands can be used to examine or modify the status of an existing batch job:

`JOB # -ABORT`	Terminates a running job
`JOB # -CANCEL`	Cancels a waiting job
`JOB # -CHANGE`	Changes entry characteristics
`JOB # -STATUS`	Shows a job's progress

PHANTOMS

Another way to execute a list of commands in a non-interactive processing mode is to use phantoms. Unlike PRIMOS batch jobs, phantoms allow CPL files to run immediately without being submitted to a queue. To start a phantom, enter:

```
PHANTOM   filename.CPL
```

The system will then display a phantom user number.

If a phantom is used to run MOSS/MAPS, you cannot enter MOSS/MAPS unless you use a different directory. However, you can do work at the PRIMOS level in the same directory while running a phantom.

If you want to cancel a phantom, use the STATUS ME command to list the phantom user number. Then enter:

```
LOGOUT  -phantom user number
```

GIS Project Management

The following project management checklist is a general procedure common to many GIS projects. Some projects may require more detailed steps in certain areas. For example, a project using remote sensing data may need more specific planning in data acquisition and classification.

PROJECT MANAGEMENT -- A CHECKLIST

I. Define project
  - A. Objectives and alternatives
  - B. Extent of study area
    - representative area
    - manageable size
    - available data
  - C. Plan of attack
    - time, money, personnel constraints
    - schedule; deadlines
    - milestones and interim products
    - responsibilities and outside contracting
    - final products and their uses
  - D. Capabilities of system
  - E. Management priority areas

II. Define Data Requirements
  - A. Themes (one theme per map)
    - coal data points
    - streams
    - roads
    - landlines
    - ownership
    - lease boundaries
  - B. Required data types
    - point
    - line
    - polygon
    - DEM (Digital Elevation Models)
    - DLG (Digital Line Graphs)
    - cell maps (dichotomous, discrete, or continuous)
  - C. Data considerations
    - accuracy
    - availability
    - vintage
    - resolution
    - scale and projection compatibilities

D. Data management
- map naming conventions
- data backups
- archiving
- tape library
- security

III. Acquire data
A. Previously digitized data
B. Other agencies as sources
- Bureau of Mines: Mining Industry Location System (MILS) data
- Geological Survey:
Mineral Resources Data System (MRDS) data
DEM
DLG
- Defense Mapping Agency: DEM
C. Data acquisition
- field work
- air photo
- satellite digital images

IV. Determine system use
A. Storage capacity
B. Processing time
C. Hardware maintenance and upgrades
D. Planned and unplanned downtime
E. Software enhancements
F. Scheduling access
G. Project directory management

V. Prepare data
A. Desired interim and final products according to software capabilities
B. Accuracy and missing data checks
C. Format requirements; reformatting if necessary
D. Adjacent maps for later edge-fitting requirements
E. Quality control
F. Time and money comparison
G. Compilation sheets
- stable media
- common errors:
edge matching
inconsistent labeling
missing data
extraneous data

VI. Enter data
- A. Loading previously digitized and acquired data
- B. Prioritizing remaining data entry according to
  - most urgent need
  - data complexity
  - data availability
- C. Digitizing steps
  (approximately 3 hours per 7-1/2 minute quadrangle map)
  - register map to tablet
  - digitize in ADS
  - plot resultant map and compare to original, i.e., verify
  - edit and/or digitize to correct errors and add data plot and verify
- D. Documenting maps and themes entered via naming conventions
- E. Managing newly entered data
  - map names
  - project files
  - archiving
  - security

VII. Conduct data transfers, reformats, and system interfaces (See Figure 1.1)
- A. ADS to MOSS (ADS2MOSS)
- B. MOSS to ADS (MOSS2ADS)
- C. DEM to MAPS (IMPORT command in MAPS)
- D. DLG to MAPS (DLGS2O, DLGO2ADS or MOSS Utility command-DLG3 option)
- E. MILS data to MOSS import format
- F. MRDS data to MOSS import format

VIII. Analyze data
- A. Project objectives and choice of analyses
- B. Construction of models
- C. Interim products

IX. Output products
- A. Limitations of output capabilities
  - resolution
  - accuracy
  - aesthetics
  - appropriateness
- B. Tables, graphs, and text output
  - text editor (EMACS)
  - MOSS/MAPS text output

C. Maps

- COS (Cartographic Output System) maps
- cartographic design of output map
    - scaleshade and color
    - theme(s)legend
    - complexity lettering
    - symbolization
- MOSS PENPLOT command (for vector maps)
- MOSS GENPLOT command (for cell and vector maps)
- ADS production plots
- GISPLOT, which reformats files from COS, PENPLOT, and GENPLOT, and creates a plot file for specified plotter

PRIMOS Review Exercise 1

The purpose of this exercise is to review selected PRIMOS commands.

1. **LOGIN** to the PRIME using your user ID and password.
2. Go down (**DOWN**) to the MOSS directory. Find your location in the system (**WHERE** command). List (**LD**) the contents of the directory. Go back up to your top level directory (**UP** or **ORIGIN**).
3. Use the **HELP** command. Respond with NO when you've seen enough of the listing of commands. Use the HELP command to obtain information on the ABBREV command.
4. List (**LD**) the files in your directory to see if you have an ABBREV file already created. List the abbreviations in the ABBREV file.

If there is no ABBREV file, create one using the **ABBREV -CR** command. Activate the new ABBREV file by using EMACS to add the following line to your login.cpl:

```
ab filename.abbrev
```

Do an ICE (Initialize_Activate_Environment) to activate the ABBREV file.

5. Add the following abbreviations to your ABBREV file:

W	where
Q	close -all;rls -all;como -end
DEL	delete
SL	slist

6. Set up the abbreviations to start MOSS with a single keystroke.

```
AB -AC M MOSS MINTRAIN username
```

7. LAC (List_Access) to display the ACL's (Access_Control_List) of a file in your directory.
8. Use **SIZE** command to list file and directory sizes.
9. Use **STATUS US** and **STATUS ME** to display user information.
10. Create and run a CPL file that starts a como file, selects and plots several maps, lists the active table, frees that active table and then closes the como file.

Chapter Two:

GIS Applications for Coal Resource Analyses

In this chapter you will

- *Generate a boundary map for the study area*
- *Generate a coal thickness grid*
- *Evaluate and customize a grid*
- *Calculate Reserve Base coal tonnage*
- *Generate a stripping mining-ratio grid*
- *Generate a mining-ratio grid using multiple Recovery Factors*
- *Create a coal potential map*
- *Generate a surface-minable coal grid*
- *Prepare a DEM for map analyses*
- *Compare collar elevations to the DEM*
- *Use DEM to generate an overburden grid*

GIS for Coal Resource Analysis — Introduction

A Geographical Information System (GIS) is well-suited for coal resource assessment activities, such as generating isopach, structure and overburden maps, calculating reserves and ranking mining potential of coal deposits. All the information in a GIS data base is identified geographically, that is, by X and Y coordinates. These coordinates can be in degrees (latitude/longitude), meters (UTMs) or feet (State Plane), but must be consistent within a study area. Attached to this geographically located information are data elements, or attributes. These attributes can include Z-values (e.g., ground surface elevation, depth to a coal seam, thickness, analytical data) and general information (e.g., drill hole identifier, date of sampling).

Once the data are in the GIS environment, the Z-values can be transformed into gridded numerical surfaces. These grids (cell maps) can then be added, subtracted, multiplied, divided, or algebraically manipulated. For example, you can generate an overburden grid by subtracting an elevation grid for the top of a coal seam from the surface elevation grid. Keep in mind that these spatial analyses can only be done with grids that have the same number of rows and columns and the same cell size; the accuracy of the GIS cannot be any greater than the data you put into the data base. New data available can easily be added to the data base to generate new grids.

Contour values for thickness, bed structure, overburden or stripping mining-ratios may extend beyond the area of interest. This may include boundaries (lease, mined areas, burn areas, channels) or other coal limitations (chemical, minimum thickness). In MOSS, the contour lines can be truncated at the polygon boundaries using the **LPOVER** command. Lines of limitation (e.g., the zero thickness contour line) must first be converted to a polygon map using the **MOSS2ADS** and **ADS** commands. In MAPS, the cell values can be limited to the area of interest by using the **RENUMBER** and **MATH** commands.

You can generate customized maps that will show the maps as overlays. This can also include other maps such as transportation networks, streams, political boundaries, leases, townships and land/mineral ownership. The ways in which they can be displayed are as follows:

a. Use the display commands such as **PLOT**, **FLOOD**, and **SHADE** to view the maps/grids on the terminal screen.

b. For vector maps only:

   (1) Use the **PENPLOT** command in MOSS to create a metafile, which can then be plotted on the screen or a plotter using **GISPLOT** in PRIMOS. These maps can be plotted to the map scale of your choice, with the size of the plotter paper being a limitingfactor.

(2) Use the **DISPLAY** command in MOSS to build a display file (filename.DP), which can be viewed on the terminal screen using **SHOW** command in PRIMOS.

c. For cell maps only:

(1) Use the **GENPLOT** command in MOSS to create a metafile, which can be plotted on the screen or a plotter using **GISPLOT**. The maps can be plotted to the map scale of your choice, with the size of the plotter paper being a limiting factor.

(2) Use the **DISPLAY** command in MAPS to create a metafile or a display file. The prefix "M." is automatically added to the metafile; the suffix ".DP" is automatically added to the display file. The metafile can be plotted on the screen or a plotter using **GISPLOT** in PRIMOS. The display file can be seen on the terminal screen using the **VIEW** command in MAPS.

d. Use the **3D** command to drape cell maps over an elevation model.

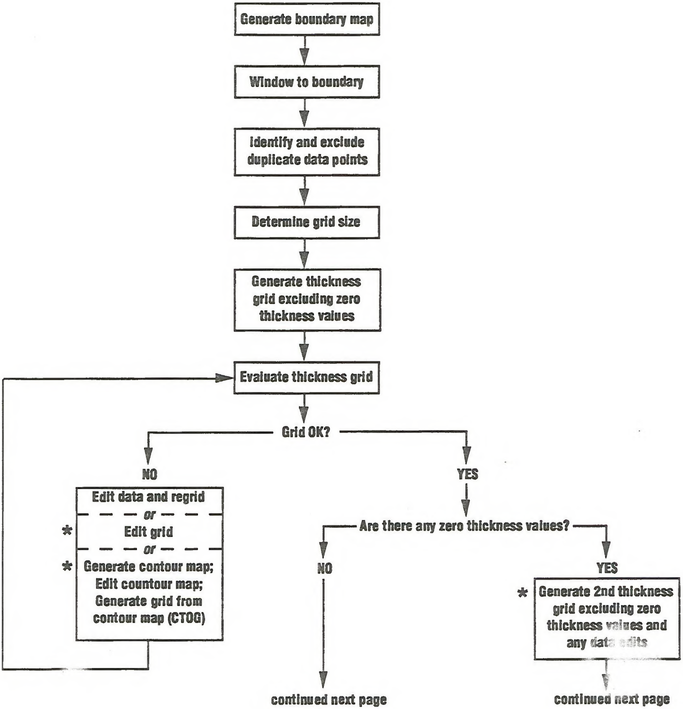
You can add text using the **TEXT** or **ANNOTATION** commands and label contours using the **AUTOLABEL** or **LEGEND-CONTOUR** commands. The Cartographic Output System (COS) allows you to produce high quality maps by using Bureau mapping standards for line styles, symbology, shading patterns, and textual information.

Flow Chart 2.1 shows the GIS process for a coal resource assessment of a study area. It was necessary to use two study areas to take you through most of the map analyses shown in the flow chart. The first study area has no Digital Elevation Model (DEM). Thus map analyses with the DEM are provided by a second study area.

Using a GIS may lead to new approaches to coal resource management, because it enables the geologist to quickly evaluate a combination of maps and study a problem in ways that would not be possible if these maps had to be compiled in a conventional manner. Geographical relationships of multiple themes that can facilitate the decision-making process can easily be shown.

Flow Chart 2.1. Processes used for map analyses

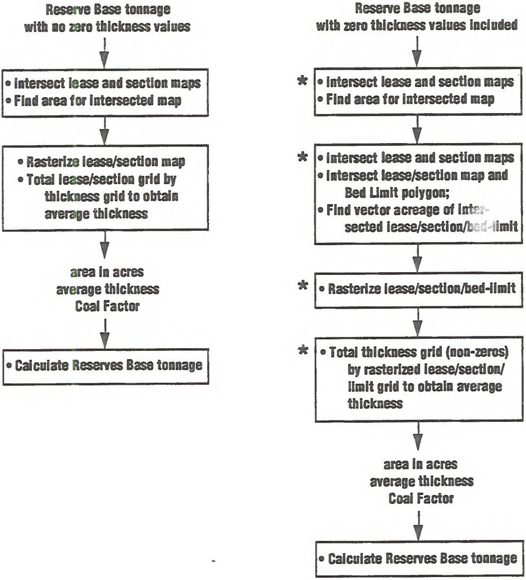
Part A: Generate the thickness grid



* *not covered in this training manual*

Flow Chart 2.1. (continued)

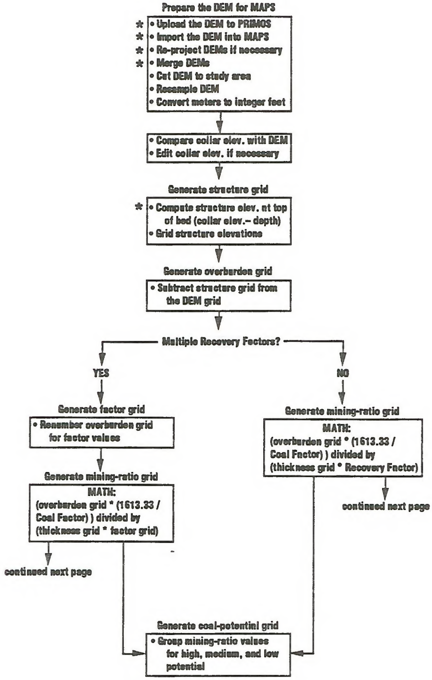
PART B: CALCULATE RESERVE BASE TONNAGE



* *not covered in this training manual*

Flow Chart 2.1. (continued)

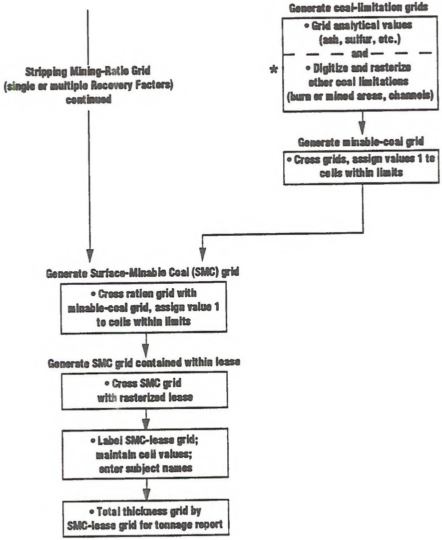
PART C:
USE DEM TO GENERATE OVERBURDEN AND STRIPPING MINING-RATIOS GRIDS



* *not covered in this training manual*

Flow Chart 2.1. (continued)

PART D:
GENERATE SURFACE-MINABLE COAL TONNAGE



* *not covered in this training manual*

GIVEN DATA FOR THE SJCOAL STUDY AREA

The SJCOAL study area is located in New Mexico. Six townships are involved in the SJCOAL study area: T23-25N and R11-12W. There are 45 coal drill holes in the western part of the study area.

Master maps in the MOSS project SJCOAL:

Master Map Name	Map Type	Map Theme
COAL.PTS	1 (point)	Coal data for 45 drill holes
COAL.SAMP	1 (point)	Coal sample data (ash, sulfur, etc.)
LANDLINES	3 (polygon)	Township, range, section
SJ.LEASE	3 (polygon)	Coal lease boundary
ROADS	2 (line)	Roads
STREAMS	2 (line)	Streams
WSA	3 (polygon)	Wilderness Study Areas

COAL EXERCISE 1

Familiarize yourself with the master maps.

In this exericise you will list, select and plot the master maps in order to become familiar with the data. You will learn how to do a Boolean search to retrieve data and how to calculate the elevation at the top of the coal bed.

a. Enter **MOSS** and the MOSSDATA directory called MINTRAIN. **OPEN** the project SJCOAL.

b. **LIST** the maps in the master directory for this study area.

c. Use **UTILITY-BROWZE** to list the master maps and their themes. The output file will automatically be named SJCOAL.BL. Use the **SLIST** command on the output file (in MOSS, use **SYSTEM SLIST** SJCOAL.BL).

d. There is a map named COAL.PTS which contains 45 drill sites and associated attributes.

   (1) **DESCRIBE** this map to become familiar with the multiple attributes, such as coal thickness, overburden, interburden, etc.

   (2) **SELECT** and **WINDOW** to COAL.PTS. **PLOT** and **QUERY** the map to obtain information about the attributes.

   (3) Create a **REPORT** with a tabular listing of several attributes associated with the drill sites.

e. To find areas that have a low mining ratio, use the **BSEARCH** command to do a Boolean search-and-select from the COAL.PTS map to find those drill holes in which the overburden is less than 30 feet and total coal thickness is greater than 15 feet. **PLOT** the selected drill holes and use the **LEGEND** command to label these points by their drill hole ID.

f. **SELECT** and **WINDOW** to the township and range map (LANDLINES). **SELECT** the rest of the master maps, excluding the subject "null" from the WSA map.

   FLOOD the lease map (SJ.LEASE) in orange

   SHADE the Wilderness Study Areas

   PLOT the landlines in white

   PLOT the streams in dark blue

   PLOT roads in red

   PLOT the data points

COAL EXERCISE 1 (cont'd)

g. The COAL.SAMP map in the data base contains information on moisture, ash, carbon, BTU's, and other sample data.

(1) **DESCRIBE** the attributes for this map.

(2) Use the **BSEARCH** command to select the sampled coal holes which have a sulfur content greater than 0.5 percent.

(3) **PLOT** the selected coal holes. Label (**LEGEND**) the point locations by sulfur content.

h. Create a new attribute:

(1) **SAVE** the COAL.PTS map and name it MYCOAL.PTS since you do not have write permission to modify a master map.

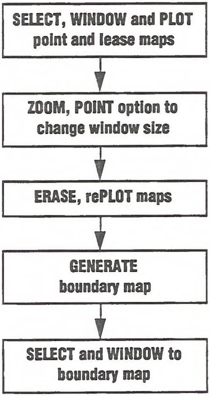
(2) SELECT MYCOAL.PTS

(3) Use the **COMPUTE** command to calculate the elevation at the top of the coal bed (elevation minus total overburden).

* Name the new attribute "coal.top"

(4) Generate a report that lists the elevation, total overburden and the new attribute "coal.top".

Flow Chart 2.2 Generate a boundary map for the study area



COAL EXERCISE 2. Generate a boundary map for the study area

Creating a boundary map for the study area:

- □ *maximizes screen view of the data points*
- □ *limits interpolation to area that is controlled by data points*

a. **GENERATE** a boundary map that includes all the points in the MYCOAL.PTS map:

(1) **SELECT** the points map (MYCOAL.PTS) and the lease map (SJ.LEASE). **WINDOW** to both maps and **PLOT** them.

(2) Because some points are at the edge of the map, use the following procedure:

(a) Use **ZOOM POINT** and a magnification factor of 0.8 to change the window. Place the crosshairs in the center of the map on the screen.

(b) **ERASE** the screen and re**PLOT** the maps. All points should now be within the edges of the map.

(3) Using the zoomed window, **GENERATE** a boundary that includes all the points and the lease boundary.

* Name the new map SJ.BORDER.

b. **SELECT** and **WINDOW** the SJ.BORDER map. **PLOT** the points map (MYCOAL.PTS) and the lease map (SJ.LEASE). All the points should now be within the border.

The ABCs of Gridding

THE GRIDDING PROCESS

The gridding process generates a raster map over the study area and, using one of the gridding algorithms, fills in the probable value for each cell. The process looks at points of observed values and then calculates values for the void cells where measurements have not been taken. The resultant grid can be used to generate a contour map (e.g., isopach map) or to conduct further analyses (e.g., subtracting structure grid from the elevation grid to produce an overburden grid).

The GRID command in MOSS provides five different gridding algorithms for determining the values for each cell. Three of these algorithms are illustrated in Figure 2.1. Also see Table 2.1. for a comparison of the advantages and disadvantages of the various gridding algorithms.

FOUR-POINT QUADRANT WEIGHTED AVERAGE

The FOUR-POINT method uses each cell as the center of a quadrant. The algorithm determines the closest data point to the center of the cell in each of the four quarters and calculates their weighted average to determine the value (z) for that cell. The greater the distance of the data point from the cell, the less influence the data point has on determining the value of the cell. It then moves on to the next cell until all cells within the grid have a value. The value (z) of the cell is determined by this formula:

$$z = \frac{z1/d1 + z2/d2 + z3/d3 + z4/d4}{1/d1 + 1/d2 + 1/d3 + 1/d4}$$

EIGHT-POINT QUADRANT WEIGHTED AVERAGE

For each cell, the EIGHT-POINT method searches for the nearest points that are within the specified moving-window size. It must find at least 3 points within the window and limits itself to a maximum of 8 nearest points. Any cell with less than 3 nearest points within the window is assigned a value of 10 less than the minimum value of the point map. A weighted average is computed based on the distances from the cell to each point. The value (z) of a cell is determined by the same formula as the FOUR-POINT method except eight point-values are used rather than four.

Simple or Universal Kriging

Kriging is a moving-average method that uses the theory of regional variables (e.g., thickness of a coal bed). To determine input values for kriging, the VARIOGRAM command must first be used to generate a semi-variogram. You should not attempt to run the kriging option without some understanding of the theory of geostatistics.

Quintic Spline Interpretation

The spline method divides the area into a network of triangles using the original data points as vertices. It then uses the nearest 3-10 data points (determined by user input) to estimate slope and gradient at each data point. The slope and gradient is used to calculate a fifth degree (quintic) interpolating polynomial over each triangle. This causes adjacent triangles to match smoothly (to spline). Finally, the program determines in which triangle the center of the cell lies and the cell value is calculated based on the polynomial over this triangle.

Nearest Neighbor (Polygon)

The nearest neighbor method determines the closest data point to the target cell and assigns the target cell that value. If more than one data point are equally closes to the target cell, the cell is assigned the average of the values. The resulting cell map appears to be made up of polygons.

CTOG (Contour to Grid)

CTOG is a MOSS command that allows you to create a grid (cell map) from an existing contour map (line map, Type 2). You must first create an export file from the contour map in MOSS using the **EXPORT** command. Secondly, use the **UTILITY-CTOG** option to reformat the export file into a MAPS import file. Thirdly, use the **IMPORT** command in MAPS to generate a grid with the import file, using the "DEM 7.5" format option.

Factors to remember when gridding

You must set the window.

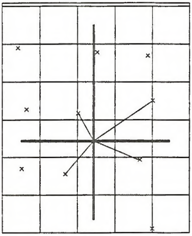
The Minimum Bounding Rectangle (MBR) of the resultant grid may be slightly different than the original window.

If the grid is used in the volumetric calculations, in most cases the acreage will be different than the vector map acreage. Thus use the average thickness obtained through this method and then manually calculate the tonnage using the acreage from the vector map.

You cannot grid with duplicate points in the Quintic Spline method. Use the Variogram command to determine whether you have duplicate points in your data set. If so, remove the duplicates before gridding.

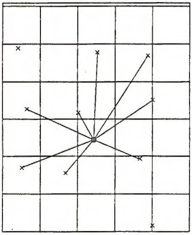
If a very small cell size is chosen and number of rows and columns are large numbers, the time to process the grid increases for the FOUR-POINT and EIGHT-POINT methods.

Figure 2.1.Grids showing how three of the gridding algorithms interpolate a cell value.



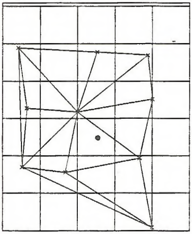
FOUR-POINT/QUADRANT WEIGHTED AVERAGE:

Searches for the closest data point in each of the quadrants



EIGHT-POINT WEIGHTED AVERAGE:

Searches for maximum of eight closest points



QUINTIC SPLINE:

Divides the area into a network of triangles using the data points as vertices. Value of the cell is then given the value of the triangle which contains it.

Determining Cell Size for the Grid

Prior to the gridding process, you should determine an appropriate grid cell size. A large cell size (few rows and columns in the grid) is less time consuming but may be also less accurate than a small cell size. You can use a large cell size for a first run. The TESTGRID command allows you to visually determine what cell size would be most useful. A very general rule is that there should be no more than 1 point to a cell and points not more than 10 cells away from each other.

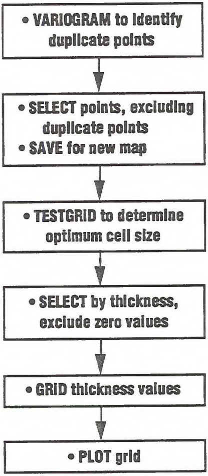
Setting the "Roving Window"

Along with the cell size, the FOUR-POINT and EIGHT-POINT gridding algorithms will ask for the size of a moving window, called a "roving window" in the MOSS manual. This is the number of cells on all sides of the target cell that the program will search for other point values to use in the interpolations. A very general rule is to use one-half the number of rows in the grid pattern for the size of the roving window.

TABLE 2.1. Comparison of the Gridding Algorithms

ALGORITHM	ADVANTAGES	DISADVANTAGES
FOUR-POINT	Works best for clustered data	Slow
EIGHT-POINT	Only method that allows use of faults Produces smooth contour maps	Slow
KRIGING	Statistically sound	Difficult to learn
QUINTIC SPLINE	Fastest	Increasing distortion outside of control points. Sees trends where data is sparse. Often has values that exceed minimum/ maximum values of the data.
POLYGON		Can't be used for contour maps
CTOG	You can contour by hand and turn your map into a grid for analyses	

FLOW CHART 2.3. Generate a coal thickness grid



COAL EXERCISE 3. Generate a coal thickness grid

a. Check for duplicate points:

(1) FREE all maps in the active table except the boundary map (SJ.BORDER), which was generated in Exercise 2. **WINDOW** to SJ.BORDER.

(2) **SELECT** the MYCOAL.PTS map.

(3) Use **VARIOGRAM** on the Active ID for MYCOAL.PTS to see if there are any duplicate points in the MYCOAL.PTS map. Use all the defaults. Use only one variogram direction with angle pairs of 22 and 0.

note:

*In this case, no duplicate points are found. If there were duplicate points, the program would have listed them by the item numbers. You would **SELECT** by ITEM, using the backslash to "not select" one of each pair of duplicate points. You would then have to **SAVE** this map and do further analyses with the new map.*

b. Use **TESTGRID** to display a grid over the study area. Use meters instead of acres. **PLOT** the MYCOAL.PTS map over the displayed grid to check if the cell size is appropriate for the gridding process.

c. Generate the grid:

(1) **BSEARCH** the MYCOAL.PTS map to obtain thickness values that are greater than zero.

note:

*Thickness of all coal beds are already totaled for the attribute COAL.THICK. If they were not totaled, you could either (a) grid each bed separately and then use the **MATH** command to add the grids; or (b) use ~~the~~ **COMPUTE** command to add the coal thickness values for the beds and create a new attribute for the total sum.*

(2) **GRID** the thickness values using the **EIGHT-POINT** and the **QUINTIC SPLINE** algorithms.

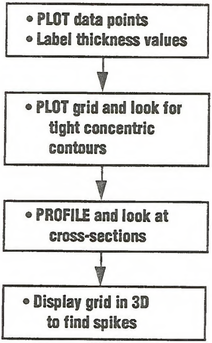
* Use a 250-meter cell size for all map analyses in these exercises.

* For the EIGHT-POINT grid, use a roving window that is one-half the number of rows; for the Quintic Spline, use a window of 7.

(3) **DESCRIBE** the grids by header to determine if they have cell values that are not within the minimum/maximum values of the data. In MAPS, **RENUMBER** values below the minimum and above the maximum values.

(4) **PLOT** the grids and graphically compare the EIGHT-POINT grid with the Quintic Spline grid.

FLOW CHART 2.4. Evaluate a thickness grid



COAL EXERCISE 4. Evaluate a thickness grid.

How do you know if the thickness grid you calculated is correct?

For some users, this "correctness" is a limit on the difference between the observed and calculated thickness values in the grid. For other users, "correctness" is the best grid one can obtain given certain limitations, such as CPU time or the amount of storage available (i.e., the size of the output grid). The geologist must also determine if the grid is geologically acceptable.

a. Here are some techniques available that help evaluate the output grid:

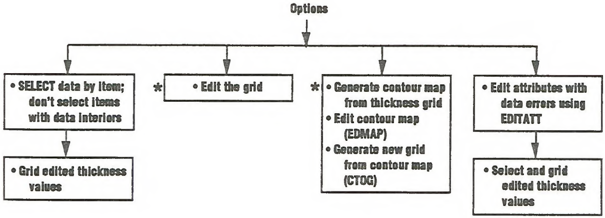
(1) **PLOT** the data points and label (**LEGEND**) them by the thickness attribute. See if any thickness values look out of line with neighboring values.

(2) You can spot data errors when the grid is plotted and there are tightly concentric contours around a point. In MOSS, **PLOT** the EIGHT-POINT grid to check for this.

(3) Use the **PROFILE** command to look at the grid in several directions in cross section. Do the cross sections look acceptable?

(4) You can also spot data errors as spikes (positive or negative) in a 3-D display. In MAPS, use the **3D** command to display the EIGHT-POINT grid to locate any spikes.

FLOW CHART 2.5. Customize a thickness grid



** not covered in this training manual*

COAL EXERCISE 5. Customize a thickness grid

a. Assuming item 1 in the point map is an erroneous data point, correct or delete it by one of the following methods and then regrid the thickness:

METHOD A

(1) **SELECT** the point map (MYCOAL.PTS) by item, using the backslash to "not select" the item 1.

(2) **SAVE** this map and give it a new name.

(3) **SELECT** saved map and re**GRID** the thickness, using the EIGHT-POINT method.

METHOD B

(1) Use **EDITATT** on the point map (MYCOAL.PTS) to edit a thickness value for item 1, giving it a new value of 1.0.

(2) Re**GRID** the edited map, using the EIGHT-POINT method.

b. **DESCRIBE** the grid by header to see if there are negative values. If so, **RENUMBER** the grid so that all the negative values are 0 (zero).

c. After you have completed the customization of the thickness grid, rename it SJTHK.GRD; we will use it in the remaining exercises in this manual.

d. **PLOT** the grid (SJTHK.GRD), data points (MYCOAL.PTS), and lease map (SJ.LEASE) on the screen.

e. Clean up files:

(1) Keep your final EIGHT-POINT grid (SJTHK.GRD).

(2) **DELETE** other thickness grids from your working area.

(3) **FREE** unnecessary maps from your active table.

FLOW CHART 2.6. Calculate Reserve Base tonnage

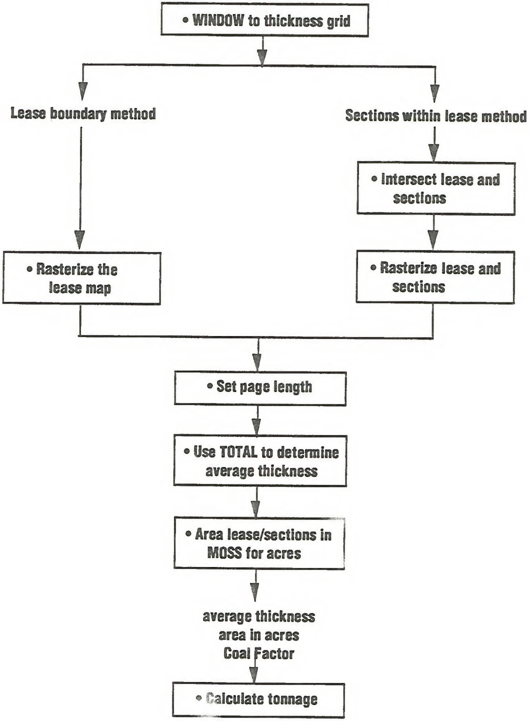


TABLE 2.2. Examples of reports from the TOTAL command for the lease and for the sections within the lease.

TOTAL REPORT PAGE 1

MAPNAME	FACTOR	CELL SIZE
SJTHK.GRD	1.000	15.444
BY PC.LEASE		

SUBJECTS	TOTAL	FREQUENCY	AREA	PRODUCT	AVERAGE
LEASE 1234	14658.	650.	10039.	226377.149	22.551
TOTAL	14658.	650.	10039.	226377.149	22.551

(BACKGROUND ACRES = 34718.)

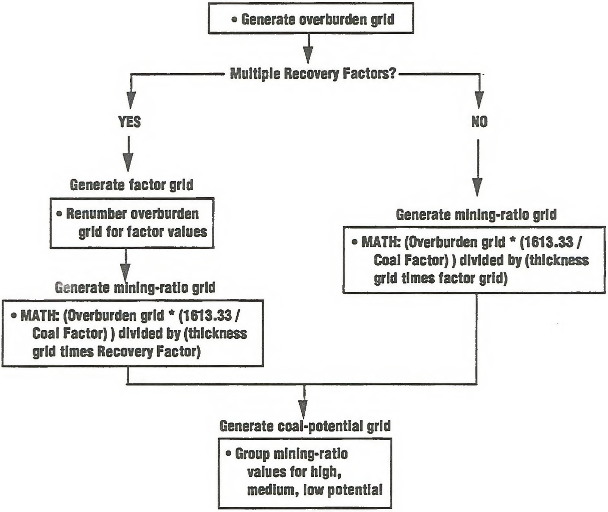
TOTAL REPORT PAGE 1

MAPNAME	FACTOR	CELL SIZE
SJTHK.GRD	1.000	15.444
BY PC.SECTION		

SUBJECTS	TOTAL	FREQUENCY	AREA	PRODUCT	AVERAGE
01; T23N.R13W	1072.	49.	757.	16558.980	21.881
02; T23N.R13W	1044.	42.	649.	16121.633	24.854
04; T23N.R12W	1313.	42.	649.	20274.015	31.256
05; T23N.R12W	1749.	40.	618.	27006.316	43.716
06; T23N.R12W	1857.	41.	633.	28678.471	45.291
07; T23N.R12W	1089.	36.	556.	16816.888	30.247
08; T23N.R12W	1050.	43.	664.	16220.969	24.426
09; T23N.R12W	1008.	46.	710.	15562.364	21.906
11; T23N.R13W	618.	36.	556.	9538.365	17.156
12; T23N.R13W	606.	42.	649.	9358.956	14.428
13; T23N.R13W	746.	49.	757.	11516.142	15.218
14; T23N.R13W	599.	42.	649.	9247.675	14.257
15; T23N.R13W	783.	49.	757.	12096.794	15.985
17; T23N.R12W	469.	48.	741.	7236.752	9.762
18; T23N.R12W	610.	42.	649.	9424.286	14.529
TOTAL	14658.	650.	10039.	226377.149	22.551

(BACKGROUND ACRES = 34718.)

FLOW CHART 2.7. Generate overburden, stripping mining-ratio and coal-potential grids



COAL EXERCISE 6. Calculate the Reserve Base tonnage

After you have edited the thickness grid and the grid meets your requirements, always window to this grid for the remaining processes. Do this because it:

- provides consistency for the project
- is time-saving to always window to one map
- meets window requirements for raster analyses, i.e., all analyses must be with maps containing the same number of rows and columns

In this study area, the coal thickness is greater than 5 feet within the lease boundary. If there were coal less than 5 feet and you wanted to limit the tonnage calculations to a coal thickness greater than this value, you would first **RENUMBER** the thickness grid, assigning the value of 0 to all cells values below 4.99.

a. Calculate the Reserve Base tonnage within the lease boundary:

(1) In MOSS, **WINDOW** to the coal thickness grid (SJTHK.GRD).

(2) **SELECT** and **POLYCELL** the lease map (SJ.LEASE) using the same cell size as the thickness grid (SJTHK.GRD).

* Name the new map PC.LEASE

(3) **DESCRIBE** the thickness grid (SJTHK.GRD) and the polycelled leasemap (PC.LEASE) to make sure the number of rows and columns are the same.

(4) In MAPS, **WINDOW** to the thickness grid (SJTHK.GRD).

(5) Use the **PAGE** command to increase page length to a large number (e.g., 3000) to prevent multiple headings in the tonnage report generated in the next step.

(6) Use the **TOTAL** command to determine the average thickness for the lease area:

- Use the thickness grid (SJTHK.GRD)
- Use a factor of 1

See Table 2.2 for an example of a report generated by the **TOTAL** command.

(7) Calculate the Reserve Base (RB) tonnage for the lease by manually (with hand calculator) multiplying the following values:

- the average thickness from the tonnage report
- the Coal Factor (1770 tons/acre-feet of coal)
- the area in acres obtained by using the **AREA** command in MOSS on the lease map (SJ.LEASE)

note:

The reason we use the acreage from the vector (MOSS) side of GIS is that rasterizing (changing a map from vector to cells) often changes the total acreage within a polygon depending on the cell size used. A cell must contain over 50 percent of the polygon to be included in the cell map. If a cell contains less than 50 percent, it is considered background.

b. Calculate the Reserve Base tonnage within each section within the lease boundary:

(1) In MOSS, **SELECT** the township/range/section map (LANDLINES). **OVERLAY** the lease map (SJ.LEASE) and the landlines map.

- Use zero characters for the lease and 16 characters for the landlines.
- Use the intersection option (menu number 1).
- Name the output map OV.SECTION (OV for overlay).

(2) **SELECT** the OV.SECTION map. **POLYCELL** the intersected map, using the same window and cell size as the coal thickness grid.

- Name the output map PC.SECTION.

(3) **DESCRIBE** the thickness grid and the rasterized section map to make sure the number of rows and columns are the same.

(4) Use the **TOTAL** command to determine the average thickness for the lease area:

- Use the thickness grid
- Use a factor of 1
- Name the output report SECTION.RPT (see Table 2.3)

c. **OPTIONAL:** Manually calculate the Reserve Base tonnage for each section within the lease boundary. Use a Coal Factor of 1770, the average thickness as shown in SECTION.RPT, and vector acreage for the sections.

COAL EXERCISE 7. Generate overburden, stripping mining-ratio, and coal potential grids

In the SJCOAL study area, a DEM is not available to use in generating an overburden grid. However, the multiple attributes attached to the data points provide overburden and interburden values.

a. Generate an overburden grid:

(1) First create a new attribute for the sum of interburden and overburden:

(a) Using the **COMPUTE** command on the Active ID of your coal data map (MYCOAL.PTS), combine the thickness of the overburden and the thickness of the interburden to create a new attribute named OVERINTB.

(2) Generate the overburden grid using the new attribute:

(a) **SELECT** and **GRID** the new attribute OVERINTB.

- Window to the thickness grid (SJTHK.GRD)
- Name the output grid OVERB.GRD
- Use the EIGHT-POINT gridding algorithm

(3) Display the overburden grid on the screen:

(a) **FLOOD** areas where the coal bed might be outcropping (where overburden is zero). There may not be outcrops in this study area.

(b) Areas where the coal beds are overlain by 200 feet or less of overburden are considered to have potential for strip mining. To visually determine if the lease has this potential, **FLOOD** the overburden grid (OVERB.GRD) for three categories:

5 through 60 feet

60.00001 through 120 feet

120.00001 through 200 feet

PLOT and **SHADE** the rasterized lease over the overburden display.

b. In MAPS, generate a stripping mining-ratio grid using a Recovery Factor and a Coal Factor:

(1) As mining ratios are based on cubic yards of overburden per ton of recoverable coal, the following conversion formula was calculated:

Cubic Yards of rock / ton of coal =

43,560 cu.ft. / acre-feet =

27 cubic ft. / cubic yard

1613.33 cubic yards/acre-feet

(2) Mining ratios are calculated using the following formula:

$$MR = \frac{To * (1613.33 / CF)}{(Tc) * RF}$$

where MR = Mining Ratio

To = thickness of overburden

1613.33 = cubic yards/acre-feet

CF = Coal Factor

Tc = thickness of coal

RF = Recovery Factor

Use the **MATH** command and substitute grids in the formula. Use a Coal Factor of 1770 (for subbituminous coal) and a Recovery Factor of .85. Name the new grid RATIO.GRD:

```
MATH ( OVERB.GRD * ( 1613.33 / 1770 ) ) / ,
( SJTHK.GRD  * .85 ) FOR RATIO.GRD
```

c. Look at the mining-ratio grid graphically:

(1) In MAPS:

(a) **FLOOD** the ratio grid using different colors to display the following four categories:

0 through 5

5.00001 through 10

10.00001 through 15

Greater than 15.00001

note:

For these exercises we have used a large cell size in order to conserve computing time. With a smaller cell size, the step-like interfaces would be less noticeable.

(b) **PLOT** the rasterized lease map (PC.LEASE) over the mining-ratio display.

(c) In MOSS, **SELECT** and **PLOT** the mining-ratio grid (RATIO.GRD), using a contour interval of five.

d. Generate a mining-ratio grid using multiple Recovery Factors:

- Recovery Factor is .85 where overburden is equal or less than 100 feet
- Recovery Factor is .50 where overburden is greater than 100 feet

(1) **RENUMBER** the overburden grid (OVERB.GRD) to reflect the above parameters. Name the new grid FACTOR.GRD.

OPTIONAL: Validate the output by flooding the overburden grid (OVERB.GRD), assigning a color from 0 feet through 100 feet. Then shade the factor grid (FACTOR.GRD), assigning 1 to .85. The area covered by these two should be the same.

(2) Use the **MATH** command and substitute grids in the mining-ratio formula. Use a Coal Factor of 1770 (for subbituminous coal) and the Recovery Factor grid (FACTOR.GRD). Name the new grid RATIOGRD.2:

```
MATH ( OVERB.GRD * ( 1613.33 / 1770 )) / ,
( SJTHK.GRD * FACTOR.GRD ) FOR RATIOGRD.2
```

OPTIONAL: Validate the output by first flooding the factor grid (FACTOR.GRD), assigning a color to .85. All cells within this area should have the same mining-ratio value for the RATIO.GRD and RATIOGRD.2. Query several cells at random, especially at the interface between .85 and .5 and see if the cells for both grids have the same mining-ratio value.

(3) **FLOOD** the new mining-ratio grid (RATIOGRD.2), using different colors to display the same four categories as you did for the first ratio grid (RATIO.GRD). **PLOT** and **SHADE** the rasterized lease grid (PC.LEASE) over this ratio grid.

e. Generate a coal development potential grid:

The definition of coal development potential changes; it is based on present-day economic and technological criteria as well as geologic criteria withinthe study area. Use the following definitions for this exercise:

MINING RATIO	DEVELOPMENT POTENTIAL
0 to 5:1	High
5:1 to 15:1	Medium
Greater than 15:1	Low

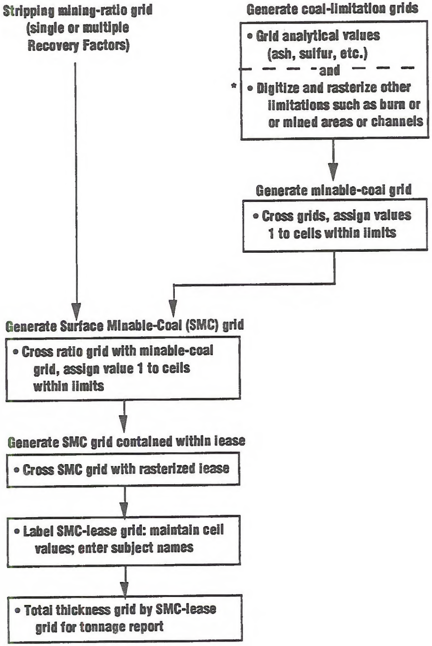
(e.g., 5:1 meaning 5 cubic yards of rock per 1 ton of coal)

(1) **RENUMBER** the cell values in the mining-ratio grid (RATIO.GRD) and group them into the three potential categories:

- Assign cell value 1 to high potential, 2 to medium, and 3 to low.
- Name the output grid COALPOT.GRD.

(2) **FLOOD** the coal potential grid (COALPOT.GRD) with different colors. The cell values are 1, 2, and 3. **SHADE** the rasterized lease map (PC.LEASE) over the grid.

FLOW CHART 2.8. Generate Surface-Minable Coal (SMC) grid and calculate SMC tonnage



** not covered in this training manual*

COAL EXERCISE 8. Generate a Surface-Minable Coal (SMC) grid and calculate SMC tonnage

A grid of surface-minable coal (SMC) can be generated to contain only those grid cells which:

(a) meet specific analytical criteria and other coal limitations (mined or burned areas, channels);

(b) meet a specific mining-ratio limit; and

(c) are within the lease boundary.

The resultant grid can then be used with the coal thickness grid to calculate the coal tonnage of surface-minable coal within the lease.

a. Generate a minable-coal grid that meets specific analytical criteria and other coal limitations:

(1) Generate grids for analytical factors that limit the coal that can be mined. Use the SULFUR and ASH attributes in the map COAL.SAMP:

- WINDOW to the thickness grid (SJTHK.GRD).
- Use the Quintic Spline option since there are only nine points in the map.
- Use the same cell size as the thickness grid.
- RENUMBER grid if there are negative values.
- Name the sulfur grid SULFUR.GRD.
- Name the ash grid ASH.GRD.

(2) CROSS the ash and sulfur grids so that cell values meeting thecriteria have a value of 1, and cell values above the criteria have a value of zero.

- Use values of 0 through 0.6 percent as an acceptable range for sulfur content.
- Use values of 0 through 20 percent as an acceptable range for ash content.
- Name the output grid MINABLE for minable coal.

EXAMPLE:

CROSS sulfur.grd **WITH** ash.grd **FOR** minable ,

ASSIGN 1 **TO** 0 **THRU** .6 **AND** 0 **THRU** 20,

ASSIGN 0 **TO** .60001 **THRU** 9999 **AND** 20.00001 **TH** 9999

note:

The first assigned values are for the sulfur grid (SULFUR.GRD).

The second assigned values are for the ash grid (ASH.GRD). The "AND" between these two phrases is a Boolean option and requires that the first condition must be met AND the second condition must be met for the new grid, MINABLE.

(3) **FLOOD** the minable-coal grid (MINABLE), assigning a color number to cells with a value of 1.

b. Generate Surface-Minable Coal (SMC) grid:

(1) **CROSS** the minable-coal grid (MINABLE) with the mining ratio grid (RATIO.GRD):

- Assign value of 1 for:

  1 through 1 cell values as the acceptable range for the minable coal.

  0.5 through 5 cell values as an acceptable range for the mining ratio.

- Name the output grid SMCOAL for surface-minable coal.

(2) **FLOOD** the minable coal (MINABLE), assigning a color to cells with a value of 1. **SHADE** the surface-minable coal (SMCOAL), assigning a shade pattern to cells with a value of 1.

c. Find the Surface-Minable Coal within the lease boundary:

(1) **CROSS** the rasterized lease (PC.LEASE) with the Surface-Minable Coal grid (SMCOAL):

- Assign a value of 1 for:

  1 through 1 cell values in the lease map.

  1 through 1 cell values in the Surface-Minable Coal grid.

- Name the new grid SMCOAL.LSE (LSE meaning lease).

(2) This new grid is without a label (subject) and will result in an error message when using the TOTAL command. Use the **LABEL** command to add a subject:

- Use 16 characters for the subject (e.g., 'SMC in lease').
- Value will remain "1."

(3) Look at the grids on the screen:

FLOOD the minable coal (MINABLE), assigning a color to cells with a value of 1.

SHADE the surface-minable coal (SMCOAL), assigning a shade pattern to cells with a value of 1.

SHADE the surface-minable coal within the lease boundary (SMCOAL.LSE), assigning another shade pattern to cells with a value of 1.

PLOT the rasterized lease boundary (PC.LEASE) in a contrasting color.

CONTOUR the thickness grid (SJTHK.GRD) with an interval of 2 and with a contrasting color.

d. Calculate the tonnage of surface-minable coal using the **TOTAL** command:

- Use the coal thickness grid (SJTHK.GRD) and the surface minable grid within the lease (SMCOAL.LSE).
- Use a factor of 1 to get the average thickness (see Table 2.3).
- Repeat the command using a coal factor of 1770 tons/acre- feet of coal (see Table 2.3).

TABLE 2.3. Example of report from the TOTAL command for the surface-minable coal within the lease boundary

TOTAL SJTHK.GRD BY SMCOAL.LSE LABEL TONS FACTOR 1

TOTAL REPORT PAGE 1

MAPNAME	FACTOR	CELL SIZE
SJTHK.GRD	1.000	15.444
BY SMCOAL.LSE		

SUBJECTS	TOTAL	FREQUENCY	AREA	TONS	AVERAGE
SURF.MIN COAL IN	7452.	261.	4031.	115086.003	28.551
TOTAL	7452	261.	4031.	115086.003	28.551

(BACKGROUND ACRES = 40726.)

TOTAL SJTHK.GRD BY SMCOAL.LSE LABEL TONS FACTOR 1770

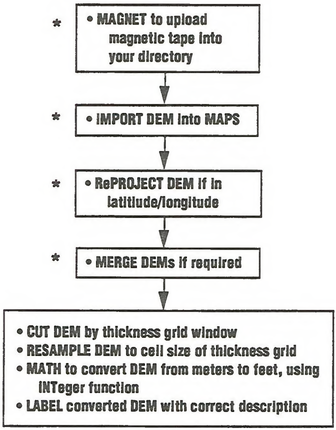
TOTAL REPORT PAGE 1

MAPNAME	FACTOR	CELL SIZE
SJTHK.GRD	1770.000	15.444
BY SMCOAL.LSE		

SUBJECTS	TOTAL	FREQUENCY	AREA	TONS	AVERAGE
SURF.MIN COAL IN	7452.	261.	4031.	203702226.089	50535.091
TOTAL	7452.	261.	4031.	203702226.089	50535.091

(BACKGROUND ACRES = 40726.)

FLOW CHART 2.9. Prepare the DEM for map analyses



* *not covered in this training manual*

Loading the DEMs for Use in MOSS/MAPS

Loading the DEM tapes and importing the files into MAPS is not covered in this manual. However, here is a brief description of the steps you must take.

Upload the DEMs:

Inform the computer operator in your office which DEM quadrangle you want uploaded, e.g., B3444106. Usually the computer operator will upload the DEM file from a tape into your directory. If this is not the case, then take the following steps:

Login into PRIME and assign the correct tape drive number. Then use the MAGNET program to transfer the data from the tape into a file in your directory.

Example:
ASSIGN MT0 [or MT1, depending on which tape drive is being used]

MAGNET

Read

MTU No.: 0 [should be same drive number used above]

File No.: 1 [or the position of the file on the tape]

Logical Record Length: 1024

Blocking Factor: 4

Ascii, binary, etc: ASCII

Diskfile: dem.name [enter the output filename]

QUIT [wait until a '>' prompt appears before you exit MAGNET]

UNASSIGN MT0 [rewinds the tape]

Importing the DEM Data into MAPS

Use the **IMPORT** command in MAPS to generate a map from the DEM file. The **FORMAT** should be "DEM 7.5" and the map **TYPE** should be "8."

Re**PROJECT** and **MERGE** several DEM maps together, if required, for your study area.

Given Data for the DHCOAL Study Area

In the DHCOAL study area, there are 45 drill holes. The DEM is in meters, has a 30-meter cell size, and covers a larger area than the drill holes. Thus, the DEM must be converted to feet, resampled to a larger cell size, and cut to fit the size of the study area.

Master maps in the MOSS project DHCOAL are:

Master Map Name	Map Type	Map Theme
DH.PLS	3 (polygon)	Township, range, section
DH.PTS	1 (point)	Coal data for 45 drill holes
DHDEM.M	8 (cell)	DEM in meters
DHSTR.GRD	8 (cell)	Structure grid for the top of a coal bed
DHTHK.GRD	8 (cell)	Thickness grid for the coal bed

EXERCISE 9. Prepare the DEM for map analyses

For the following exercises, you need to change projects within the Master directory MINTRAIN. **OPEN** to the project DHCOAL.

a. In MOSS, **DESCRIBE** the DEM (DHDEM.M) by header. Note that the minimum and maximum values are 1864 meters and 3064 meters. **DESCRIBE** the DEM by projection. Note that the map is in the UTM projection.

b. **WINDOW** to the thickness grid (DHTHK.GRD). **CUT** the DEM by the window so that it has the same number of rows and columns as the thickness grid:

- Name the cut map DEM.CUT.

c. **RESAMPLE** the cut DEM so that it has the same cell size as the thickness grid:

- Name the resampled map DEM.RES.

d. Convert the resultant grid from meter to feet using the **MATH** command:

- Use the **INT** function.
- Multiply by a conversion factor of 3.28083989.
- Name the converted map DEM.FT.

e. **DESCRIBE** (by header) the converted DEM (DEM.FT) and the thickness grid (DHTHK.GRD) to make sure the number of rows and columns are the same.

f. Use the **LABEL** command in MAPS to change the description of the converted DEM so that it reads "DEM in feet."

g. Clean up the files:

(1) Keep the DEM, in feet (DEM.FT).

(2) **DELETE** the following grids:

DEM.CUT

DEM.RES

FLOW CHART 2.10. Compare collar elevations to DEM elevations

• WINDOW to DEM, in feet

↓

Compare collar elevation with DEM elevation:

- Rasterize collar elevation
- Rasterize subjects
- Subtract collar elev. from DEM
- Categorize resultant cell values
- Increase page length
- Total rasterized subjects with categorized map to generate report showing differences

COAL EXERCISE 10. Compare collar elevations to DEM elevations

You will now use the following sequence of commands to compare the collar elevations of the drill holes to the DEM elevations at the same point location:

POLYCELL (rasterize) observed values

POLYCELL (rasterize) subjects

MATH (subtract)

CATEGORIZE

PAGE

TOTAL

a. Generate the rasterized maps:

(1) In MOSS, **WINDOW** to the DEM in feet (DEM.FT).

(2) **SELECT** and **POLYCELL** the point map (DH.PTS) twice, once for the attribute option and once for the subject option.

(a) The attribute option:

- Name the output grid PC.COLLAR.
- Use same cell size as thickness grid (DHTHK.GRD).
- Choose option 2 (discrete map Type 7) for "new cell map type."

NOTE: This must be a Type 7.

- Choose option 6 (multiple attribute option) for "cell assign ment option."
- Choose the attribute COLLAR.ELV.

(b) The subject option:

- Name the output grid PC.SUBJ.
- Use same cell size as thickness grid (DHTHK.GRD).
- Choose option 2 (discrete map Type 7) for "new cell map type."
- Choose option 2 (subject option) for "cell assignment option."

b. In MAPS, use the **MATH** command to subtract the DEM grid (DEM.FT) from the collar elevation grid (PC.COLLAR):

- Name the residual grid DIFF.

c. Obtain a listing of differences in the elevations:

(1) **CATEGORIZE** the residual grid (DIFF) to create a Type 7 grid; a Type 7 grid is needed for the TOTAL command:

* Name the output grid DIFF.T7 (T7 for Type 7).

(2) Set the **PAGE** length to a large number (e.g., 3000) so that the generated report will be continuous, i.e., without multiple headings.

(3) **TOTAL** the categorized map (DIFF.T7) with the polycelled subject grid (PC.SUBJ):

- Use the 'LABEL' option for the report.

(4) In PRIMOS, **SLIST** the report, which lists the elevation differences (column marked 'TOTAL') and the subjects. See Table 2.5 for an example table. The differences may be found under the header 'TOTAL.'

OPTIONAL: Find only those differences that are greater than plus/minus 50 feet in elevation.

(1) **CATEGORIZE** the residual grid (DIFF) twice, once to create grid for plus values and again for minus values:

- Use the **FROM** option (FROM 50 TH 9999).

  Name the output grid DIFF.T7P (T7 for Type 7 and P for 'plus values').

- Use the **FROM** option (FROM -9999 TH -50)

  Name the output grid DIFF.T7M (T7 for Type 7 and M for 'minus values').

(2) Set the **PAGE** length to a large number (e.g., 3000).

(3) **TOTAL** each of the categorized maps (DIFF.T7P and DIFF.T7M) with the polycelled subject grid (PC.SUBJ):

- Use the LABEL option to generate the reports.

d. Clean up the files:

(1) **DELETE** the following grids:

PC.COLLAR	DIFF.T7
PC.SUBJ	DIFF.T7M
DIFF	DIFF.T7P

(2) **FREE** unnecessary maps/grids from your active table.

TABLE 2.4 Summary table for the differences, in feet, of collar elevation and the DEM elevation.

NOTE: The difference in elevation is listed under the header 'TOTAL'.

TOTAL REPORT PAGE 1

MAPNAME	FACTOR	CELL SIZE
DIFF2	1.000	15.444
BY PC.SUBJ		

SUBJECTS	TOTAL	FREQUENCY	AREA	PRODUCT	AVERAGE
DH-1	39.	1.	15.	602.319	39.000
DH-10	69.	1.	15.	1065.642	69.000
DH-12	33.	1.	15.	509.655	33.000
DH-13	17.	1.	15.	262.549	17.000
DH-14	-4.	1.	15.	-61.776	-4.000
DH-15	30.	1.	15.	463.323	30.000
DH-16	-19.	1.	15.	-293.438	-19.000
DH-18	109.	1.	15.	1683.405	109.000
DH-19	33.	1.	15.	509.655	33.000
DH-2	89.	1.	15.	1374.524	89.000
DH-20	-134.	1.	15.	-2069.508	-134.000
DH-21	338.	1.	15.	5220.101	338.000
DH-22	6.	1.	15.	92.665	6.000
DH-23	3.	1.	15.	46.332	3.000
DH-24	55.	1.	15.	849.425	55.000
DH-25	-17.	1.	15.	-262.549	-17.000
DH-26	177.	1.	15.	2733.603	177.000
DH-27	-183.	1.	15.	-2826.268	-183.000
DH-29	-39.	1.	15.	-602.319	-39.000
DH-3	29.	1.	15.	447.878	29.000
DH-30	-68.	1.	15.	-1050.198	-68.000
DH-31	108.	1.	15.	1667.961	108.000
DH-32	243.	1.	15	3752.913	243.000
DH-33	84.	1.	15.	1297.303	84.000
DH-34	193.	1.	15.	2980.709	193.000
DH-35	-36.	1.	15.	-555.987	-36.000
DH-36	-86.	1.	15.	-1328.191	-86.000
DH-37	33.	1.	15.	509.655	33.000
DH-38	-4.	1.	15.	-61.776	-4.000
DH-39	0.	1.	15.	0.000	0.000
DH-4	-158.	1.	15.	-2440.166	-158.000
DH-40	-27.	1.	15.	-416.990	-27.000
DH-41	-23.	1.	15.	-355.214	-23.000
DH-42	-29.	1.	15.	-447.878	-29.000
DH-43	3.	1.	15.	46.332	3.000
DH-44	36.	1.	15.	555.987	36.000
DH-45	29.	1.	15.	447.878	29.000
DH-5	158.	1.	15.	2440.166	158.000
DH-6	56.	1.	15.	864.869	56.000
DH-7	11.	1.	15.	169.885	11.000
DH-8	-3.	1.	15.	-46.332	-3.000
DH-9	-13.	1.	15.	-200.773	-13.000

FLOW CHART 2.11. Use DEM to generate an overburden grid.

• WINDOW to thickness grid

↓

• Subtract the structure grid from the DEM

COAL EXERCISE 11: Use DEM to generate an overburden grid

a. Generate an overburden grid using the structure grid (DHSTR.GRD) and the DEM in feet (DEM.FT):

(1) In MAPS, **WINDOW** to the thickness grid (DHTHK.GRD).*

(2) Use the **MATH** command to subtract the structure grid (DHSTR.GRD) from the DEM (DEM.FT):

- Name the resultant grid OVERB.DEM.

(3) **DESCRIBE** the overburden grid (OVERB.DEM) by header to determine the minimum and maximum values. Note that there are negative values, indicating that there is an outcrop area. **RENUMBER** the negative values to zero.

(4) Use the **FLOOD** command to display where the outcrop area is located.

(5) **CONTOUR** the renumbered overburden grid over the outcrop area you flooded in the previous step.

Appendix

Answers: Coal Exercise 1

STEP A

```
MOSS MINTRAIN username
OPEN SJCOAL
FREE ALL
```

STEP B

```
LIST MASTER
```

STEP C

```
UTILITY
7
SJCOAL
1
SYSTEM SLIST SJCOAL.BL
```

STEP D

```
DESCRIBE COAL.PTS AT
4
1
SELECT COAL.PTS ALL
WINDOW #          [# = Active table ID number]
ERASE - PLOT #
QUERY
/* CROSSHAIRS
0
REPORT #
COAL.RPT
Y
N
3
BEDS
3
COAL.THICK
3
TOT.OVERB
1
SYSTEM SLIST COAL.RPT
```

Step E

```
BSEARCH COAL.PTS
TOT.OVERB LT 30 AND COAL.THICK GT 15
ERASE - PLOT #
LEGEND # LABEL
4
```

Step F

```
SELECT SJ.LEASE ALL
SELECT WSA SUBJECT
\NULL
SELECT LANDLINES ALL
SELECT STREAMS ALL
SELECT ROADS ALL
ERASE - FLOOD # COLOR 8
SHADE #
PLOT # # # # COLOR 1 4 2 1
```

Step G

```
DESC COAL.SAMP AT
4
1
BSEARCH COAL.SAMP
SULFUR GT .5
ERASE - PLOT #
LEGEND # LABEL
3
SULFUR
```

Step H

```
SAVE #
MYCOAL.PTS
SELECT MYCOAL.PTS AL
COMPUTE #
ELEVATION - TOT.OVERB
COAL.TOP
REPORT #
COAL.RPT2
YES
NO
3
ELEVATION
3
TOT.OVERB
3
COAL.TOP
1
SYSTEM SLIST COAL.RPT2
```

Answers: Coal Exercise 2

STEP A

```
SELECT MYCOAL.PTS ALL
SELECT SJ.LEASE ALL
WINDOW # #        [# = Active table ID number]
PLOT # #
ZOOM POINT
.8
/* crosshairs
ERASE
PLOT # #
GENERATE
SJ.BORDER
MYCOAL.PTS
EXERCISE2
1990
BOUNDARY FOR COAL HOLES
YES
1
3
C
R
1
/* crosshairs
Q
```

STEP B

```
SELECT SJ.BORDER ALL
WINDOW #
ERASE
PLOT # #
```

Answers: Coal Exercise 3

STEP A

```
FREE ALL
SELECT SJ.BORDER ALL
WINDOW #            [# = Active table ID number]
SELECT MYCOAL.PTS AT
3
COAL.THICK
1
VARIOGRAM #
3
COAL.THICK
TITLE
NO
NO
NO
YES
1000
5
22
0
22
22
22
45
22
60
22
90
NO
YES
COAL.VARIO
```

STEP B

```
TESTGRID
M
250
250
N
PLOT #
```

STEP C

```
BSEARCH MYCOAL.PTS
COAL.THICK GT 0
GRID #
GRD.8PT
3
/* 2 carriage returns for defaults
1
GRID FOR SJCOAL
M
250
250
N
3
COAL.THICK
22
GRID #
GRD.QS
5
/* carriage return for default
1
GRID OF COAL.PTS QS
M
250
250
N
3
COAL.THICK
7
N
DESCRIBE GRD.8PT HEADER
DESCRIBE GRD.QS HEADER
MAPS
RENUMBER GRD.QS FOR GRDR.QS AS 3 TO -9999 TH 3 AS 55 TO 55 TH
9999
BYE
SELECT GRD.8PT ALL
SELECT GRD.QS ALL
PLOT # # COLOR 2 4
5,0,55
5,0,55
```

Answers: Coal Exercise 4

STEP A

```
SELECT GRD.8PT ALL
WINDOW #[# - Active table ID number]
SELECT MYCOAL.PTS ALL
ERASE
PLOT #
LEGEND # LABEL
3
COAL.THICK
ERASE
PLOT # COLOR 5
2,4,54
PROFILE #  /* use crosshairs to create profile
ERASE
MAPS
3D GRD.8PT RO 45 AB 30 INT 1 MAG 2
ERASE
BYE
```

Answers: Coal Exercise 5

STEP A

```
SELECT MYCOAL.PTS ITEM
\1
SAVE #                    [# = Active table ID number]
MYPTS.NEW
SELECT MYPTS.NEW AT
3
COAL.THICK
1
GRID #
SJTHK.GRD
3
/* two carriage returns for defaults
1
GRID FOR SJCOAL
M
250
250
N
3
COAL.THICK
22
```

STEP B

```
DESCRIBE SJTHK.GRD HEADER
MAPS
RENUMBER SJTHK.GRD FOR SJTHK.GRDR AS 0 TO -999 TH 0
```

STEP C

```
DELETE SJTHK.GRD
RENAME SJTHK.GRDR TO SJTHK.GRD
BYE
```

STEP D

```
SELECT SJTHK.GRD ALL
SELECT SJ.LEASE ALL
ERASE
PLOT # # # COLOR 5 4 2
2,4,54
```

Answers: Coal Exercise 6

STEP A

```
SELECT SJTHK.GRD ALL
WINDOW #[# = Active table ID number]
SELECT SJ.LEASE ALL
POLYCELL #
PC.LEASE
POLYCELLED LEASE
M
250
250
2
2
DESC SJTHK.GRD HEADER - DESC PC.LEASE HEADER
MAPS
WINDOW SJTHK.GRD
PAGE 3000
TOTAL SJTHK.GRD BY PC.LEASE FACTOR 1 FOR LEASE.RPT
BYE
SYSTEM SLIST LEASE.RPT
AREA #
/* calculate tonnage using vector acreage
/* (area) * (avg. thickness) * (factor) = tonnage
/* (9933.02) * (22.551) * (1770) = 396,479,175 tons
```

STEP B

```
SELECT LANDLINES ALL
OVERLAY # #
OV.SECTION
YES
0
16
1
OVERLAY
1991
SJCOAL
OVERLAY OF LEASE AND SECTIONS
YES
SELECT OV.SECTION ALL
POLYCELL #
PC.SECTION
SECTIONS WITHIN THE LEASE
```

```
M
250
250
2
2
MAPS
TOTAL SJTHK.GRD BY PC.SECTION FACTOR 1 FOR SECTION.RPT
BYE
SYSTEM SLIST SECTION.RPT
```

OPTIONAL

```
AREA #              [AREA the vector map OV.SECTION]
```

/* use calculator to determine tonnage per section within the lease, using vector acreage

SUBJECTS	VECTOR AREA	*	FACTOR	*	AVG. THK	=	TONNAGE
01; T23N.R13W	632.01		1770		21.881		
02; T23N.R13W	627.20		1770		24.854		
04; T23N.R12W	685.38		1770		31.256		
05; T23N.R12W	668.10		1770		43.716		
06; T23N.R12W	665.03		1770		45.291		
07; T23N.R12W	688.12		1770		30.247		
08; T23N.R12W	702.85		1770		24.426		
09; T23N.R12W	683.35		1770		21.514		
11; T23N.R13W	662.08		1770		17.156		
12; T23N.R13W	658.02		1770		14.428		
13; T23N.R13W	633.74		1770		15.218		
14; T23N.R13W	649.28		1770		14.227		
15; T23N.R13W	643.10		1770		15.985		
17; T23N.R12W	671.31		1770		9.762		
18; T23N.R12W	663.45		1770		14.529		
TOTALS	9933.01 (acres)						

Answers: Coal Exercise 7

STEP A

[# = Active table ID number]

```
COMPUTE #
TOT.OVERB + TOT.INTERB
OVERINTB
SELECT MYCOAL.PTS AT
3
OVERINTB
1
GRID #
OVERB.GRD
3
/* three carriage returns
GRID, 8PT, FOR OVERBURDEN
M
250
250
N
3
OVERINTB
22
```

STEP B

```
MAPS
WINDOW SJTHK.GRD
MATH ( OVERB.GRD * ( 1613.33 / 1770 ) ) / ,
( SJTHK.GRD * .85   ) FOR RATIO.GRD
```

STEP C

```
ERASE
FLOOD RATIO.GRD AS 2 TO 0 TH 5 AS 3 TO 5.00001 TH 10 ,
AS 4 TO 10.00001 TH 15 AS 11 TO 15.00001 TH 9999
PLOT PC.LEASE
SHADE PC.LEASE AS 1 TO 1
BYE
SELECT RATIO.GRD AL
PLOT # C 4
5,0,15
```

STEP D

```
MAPS
RENUMBER OVERB.GRD FOR FACTOR.GRD AS .85 TO 0 TH 100 ,
AS .5 TO 100.00001 TH 9999
MATH ( OVERB.GRD * ( 1613.33 / 1770 ) ) / ,
( SJTHK.GRD * FACTOR.GRD ) FOR RATIOGRD.2
ERASE
FLOOD RATIOGRD.2 AS 2 TO 0 TH 5 AS 3 TO 5.00001 TH 10 ,
AS 4 TO 10.00001 TH 15 AS 11 TO 15.00001 TH 9999
PLOT PC.LEASE
SHADE PC.LEASE AS 1 TO 1
```

STEP E

```
RENUMBER RATIO.GRD FOR COALPOT.GRD AS 1 TO 0 TH 5 ,
AS 2 TO 5.00001 TH 15 AS 3 TO 15.00001 TH 9999
ERASE
FLOOD COALPOT.GRD AS 2 TO 1 AS 3 TO 2 AS 4 TO 3
PLOT PC.LEASE
SHADE PC.LEASE AS 1 TO 1
```

Answers: Coal Exercise 8

STEP A

```
SELECT SJTHK.GRD AL
WINDOW #          [# = Active table ID number]
SELECT COAL.SAMP AT
3
SULFUR
1
SELECT COAL.SAMP AT
3
ASH
1
GRID #
SULFUR.GRD
5
<CR>
1
GRID FOR SJCOAL SULFUR PERCENTAGE
M
250
250
N
3
SULFUR
5
N
GRID #
ASHGRD
5
<CR>
1
GRID FOR SJCOAL ASH CONTENT
M
250
250
N
3
ASH
5
N
DESCRIBE SULFUR.GRD H - DESCRIBE ASHGRD H
MAPS
WINDOW SJTHK.GRD
```

```
RENUMBER ASHGRD FOR ASH.GRD AS 0 TO -50 TH 0
DELETE ASHGRD
CROSS SULFUR.GRD WITH ASH.GRD FOR MINABLE ,
AS 1 TO 0 TH .6 AND 0 TH 20 ,
AS 0 TO .60001 TH 9999 AND 20.00001 TH 9999
FLOOD MINABLE AS 4 TO 1
ERASE
```

STEP B

```
CROSS MINABLE WITH RATIO.GRD FOR SMCOAL ,
AS 1 TO 1 TH 1 AND 0.5 TH 5
FLOOD MINABLE AS 4 TO 1
SHADE SMCOAL AS 3 TO 1
ERASE
```

STEP C

```
CROSS PC.LEASE WITH SMCOAL FOR SMCOAL.LSE ,
AS 1 TO 1 TH 1 AND 1 TH 1
LABEL SMCOAL.LSE SU
16
3
1
<CR>
SMC IN LEASE
<CR>
1
FLOOD MINABLE AS 4 TO 1
SHADE SMCOAL AS 3 TO 1
SHADE SMCOAL.LSE AS 9 TO 1
COLOR 2
PLOT PC.LEASE
COLOR 1
CONTOUR SJTHK.GRD INT 1
```

STEP D

```
TOTAL SJTHK.GRD BY SMCOAL.LSE LABEL TONS FACTOR 1
TOTAL SJTHK.GRD BY SMCOAL.LSE LABEL TONS FACTOR 1770
```

Answers: Coal Exercise 9

Step A

```
DESCRIBE DHDEM.M HEADER
DESCRIBE DHDEM.M PROJECTION
```

Step B through F

```
MAPS
WINDOW DHTHK.GRD
CUT DHDEM.M WINDOW FOR DEM.CUT
RESAMPLE DEM.CUT FOR DEM.RES SIZE 250
MATH INT ( DEM.RES * 3.28083989 ) FOR DEM.FT
DESCRIBE DEM.FT HEADER
DESCRIBE DHTHK.GRD HEADER
LABEL DEM.FT HEADER
DEM IN FEET
OZ
1991
WILSON
1991
```

Step G

```
DELETE DEM.CUT
DELETE DEM.RES
BYE
BYE
```

Answers: Coal Exercise 10

STEP A

```
SELECT DEM.FT ALL
WINDOW #[# = Active table ID number]
SELECT DH.PTS ALL
POLYCELL #
PC.COLLAR
POLYCELLED COLLAR ELEVATION
M
250
250
2
6
3
COLLAR.ELV
POLYCELL #
PC.SUBJ
POLYCELLED POINT MAP, SUBJECT
M
250
250
2
2
```

STEPS B AND C

```
MAPS
WINDOW DEM.FT
MATH PC.COLLAR - DEM.FT FOR DIFF
CATEGORIZE DIFF FOR DIFF.T7
PAGE 3000
TOTAL DIFF.T7 BY PC.SUBJ LABEL DIFF.RPT
SYSTEM SLIST DIFF.RPT
```

STEP D

```
DELETE PC.COLLAR
DELETE DIFF.T7
DELETE PC.SUBJ
DELETE DIFF.T7M
DELETE DIFF
DELETE DIFF.T7P
BYE
FREE # # # # # # TH #
```

OPTIONAL

```
MAPS
CATEGORIZE DIFF FROM 50 TH 9999 FOR DIFF.T7P
CATEGORIZE DIFF FROM -9999 TH -50 FOR DIFF.T7M
PAGE 3000
TOTAL DIFF.T7P BY PC.SUBJ FOR PLUS.RPT
TOTAL DIFF.T7M BY PC.SUBJ FOR MINUS.RPT
SYSTEM SLIST PLUS.RPT
SYSTEM SLIST MINUS.RPT
BYE
BYE
```

Answers: Coal Exercise 11

STEP A

```
MAPS
WINDOW DHTHK.GRD
MATH DEM.FT - DHSTR.GRD FOR OVERB.DEM
DESCRIBE OVERB.DEM HEADER
RENUMBER OVERB.DEM FOR OVERB.DEM2 AS 0 TO -9999 TH 0
FLOOD OVERB.DEM AS 7 TO -9999 TH 0
CONTOUR OVERB.DEM2 INT 100
```